Attitude of Planes and Lines
Stereographic projection

Lab 1

Attitude of Planes and Lines

Attitude: general term for the orientation of a plane or line in space.

How would you specify attitude of a line/plane in space?

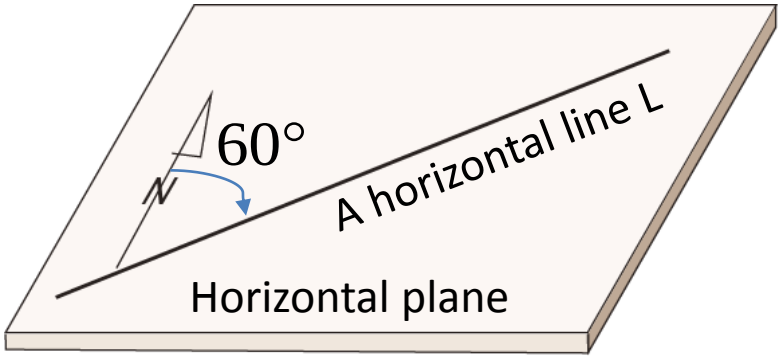
Simple examples:

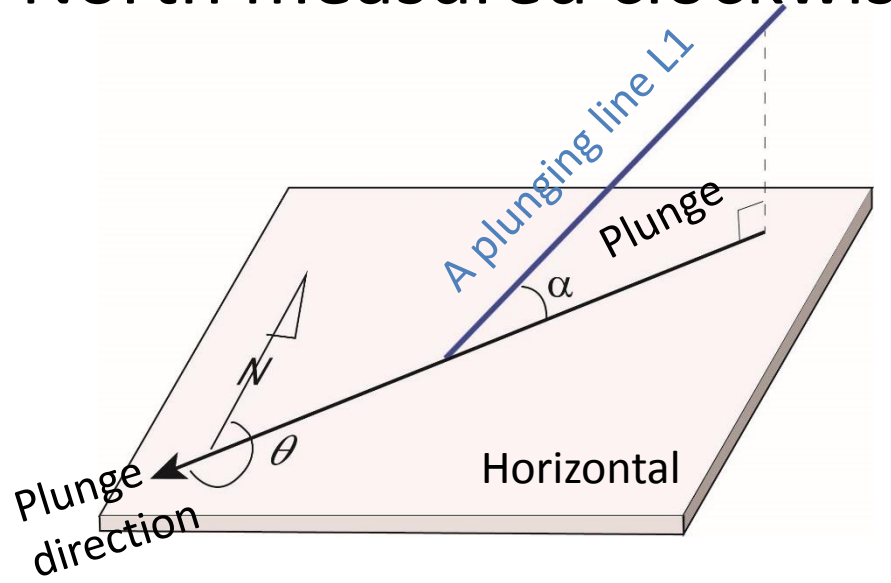
start with lines: vertical line; horizontal line

Attitude of Lines

Trend (bearing): the direction of a line in a horizontal plane, specified by its azimuth.

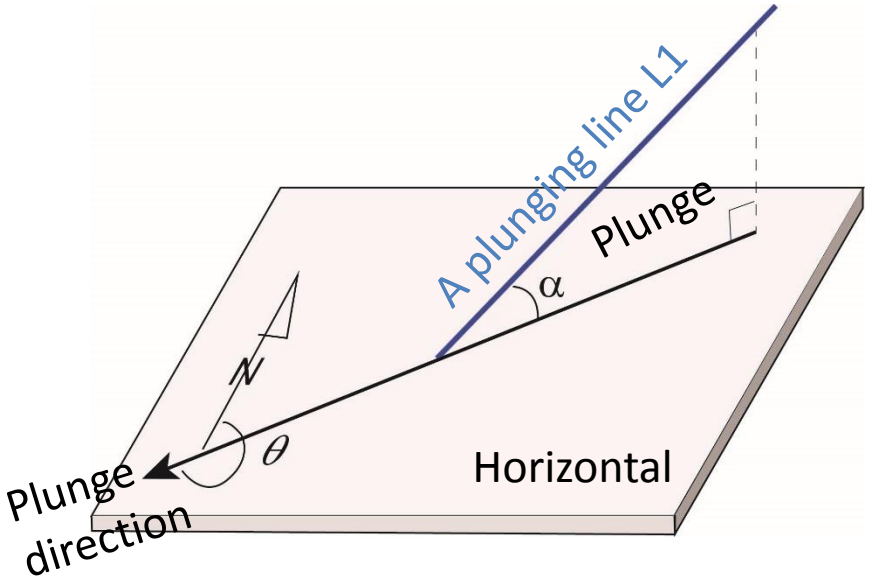
Azimuth: the angle of a horizontal line with respect to the true North measured clockwise.





To specify the attitude of a line, we use plunge and plunge direction

Representation of attitude of a line



Line L1 plunges 30° towards 240°.

Representation of attitude of a line:

plunge, plunge direction (trend)

xx (2 digits) xxx (3 digits for azimuth)

$30°,240°$ (Recommended)

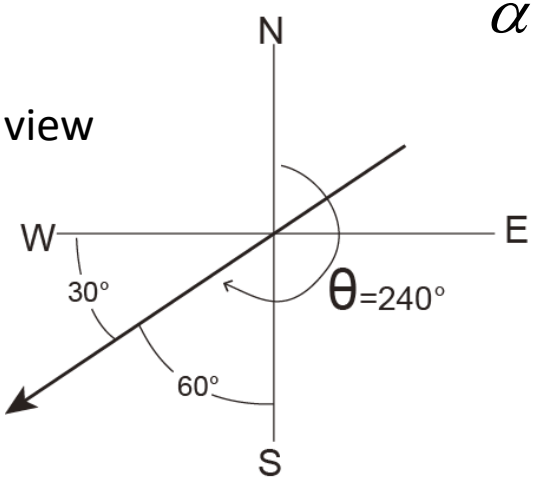
$30°,S60°W$ (quadrant format)

$30°,W30°S$

$30° \rightarrow 240°$

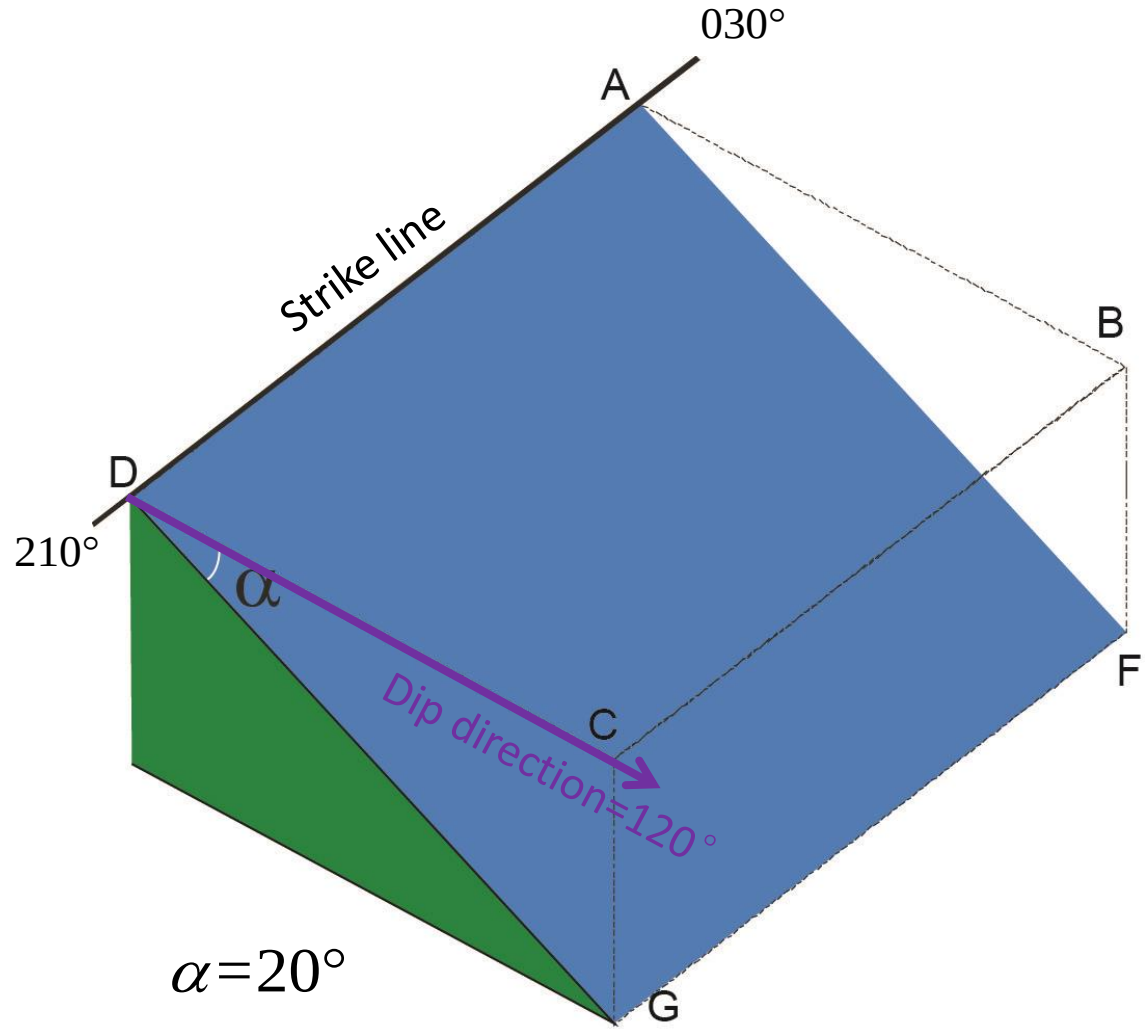
$\alpha = 30°$

Plan view



Practice: Line L2 plunges 2 ° towards 25°

Attitude of planes



Lines plunge; planes dip

Plane ABCD: horizontal plane

Plane AFGD as an example

Dip: angle between the plane (plane AFGD) and a horizontal plane (plane ABCD)

Dip of Plane AFGD: α

Strike: Direction of a horizontal line in the plane

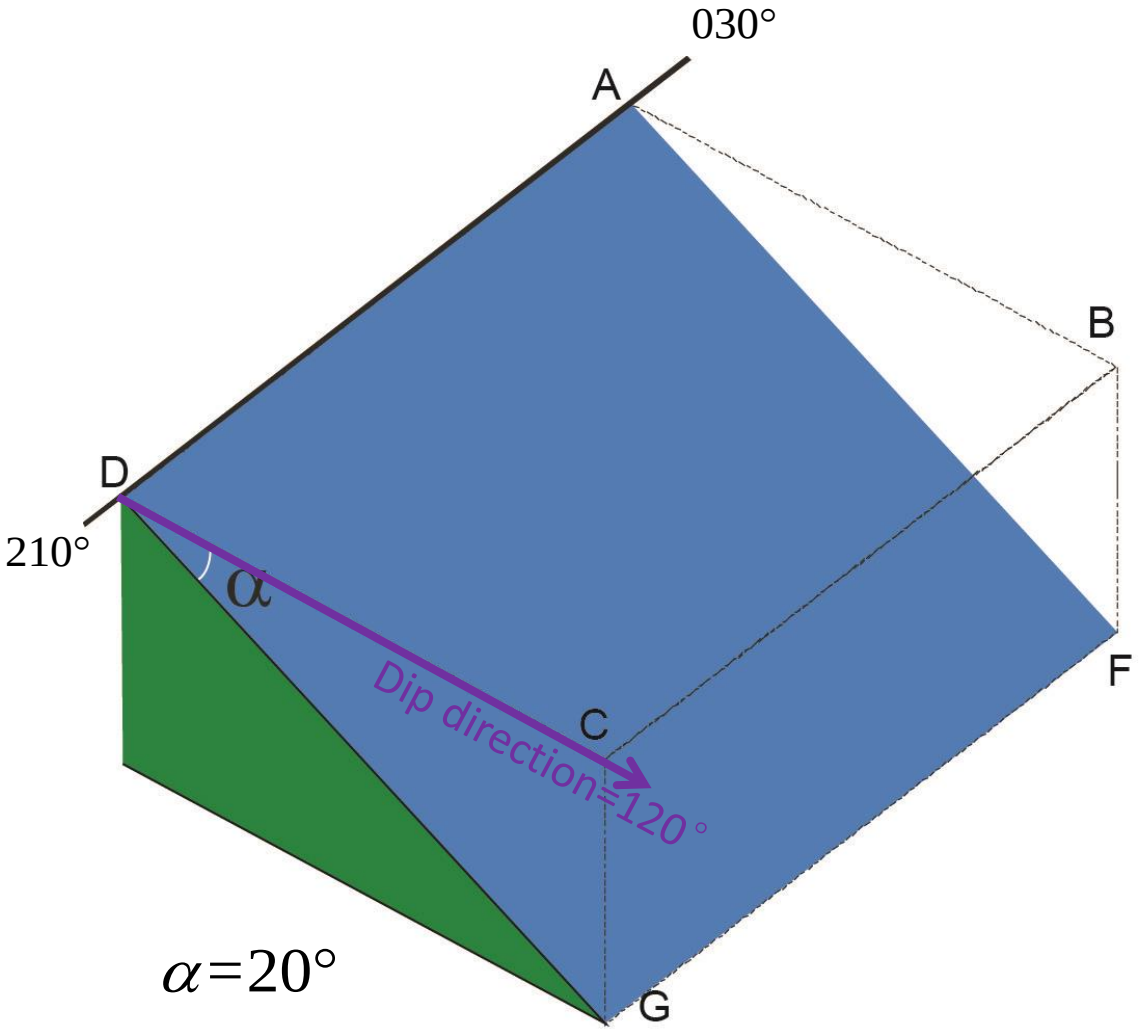
Strike of Plane AFGD: 30° or 210°

Dip direction: Direction perpendicular to the strike and along the downslope of the plane

Dip direction of Plane AFGD: 120°

Representation of attitude of planes

Plane AFGD dips 20° towards 120°.



Representation (two methods):
Plane AFGD as an example

Strike, dip

xxx, xx

030°, 20° (right hand rule; recommended)

210°, 20°SE

N30°E, 20°SE

S30°W, 20°SE

Can use "/" instead of "," (e.g., 030°/20°)

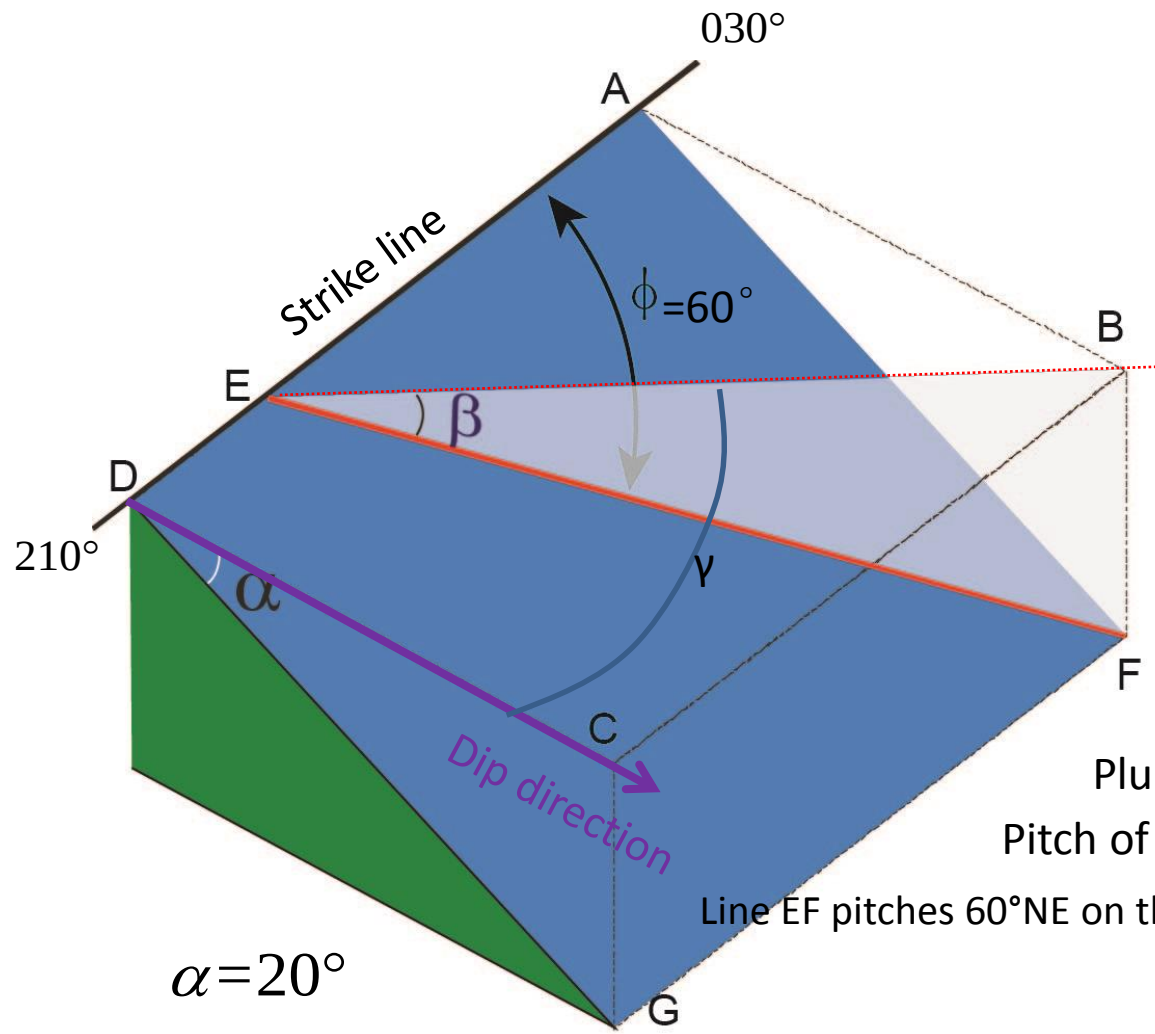
Dip, dip direction

xx, xxx

20°, 120°

Can use "->" instead of ","

Apparent dip; Pitch



Plane AFGD

Dip: α (True dip)
Measured on a vertical plane that is perpendicular to the strike line

Apparent dip: β
Measured on a vertical plane that is NOT perpendicular to the strike line

Plunge direction of line EF ?
Apparent dip direction of plane AFGD observed on the vertical section EBF?

Apparent dip direction: Along the strike of the vertical plane and downslope.

Plunge direction of line EF: $\overrightarrow{EB}$

Pitch of line EF on plane AFGD: 60°NE

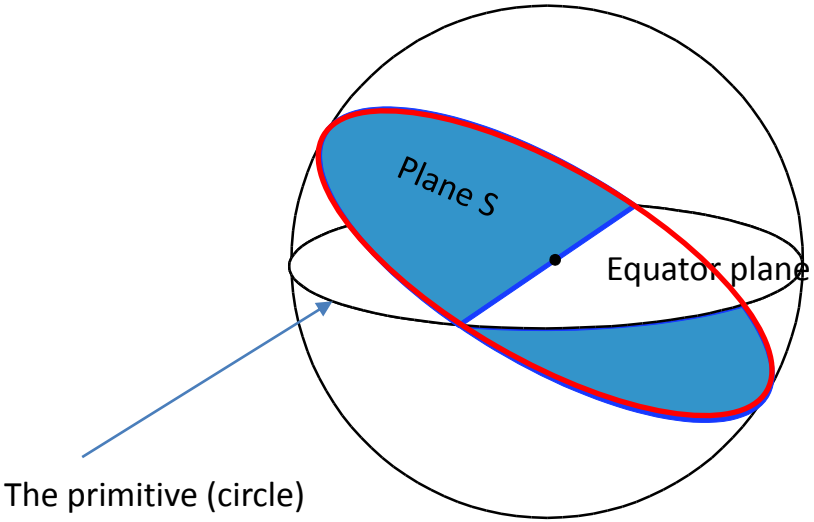
Line EF pitches 60°NE on the plane AFGD which dips 20° towards 120 °

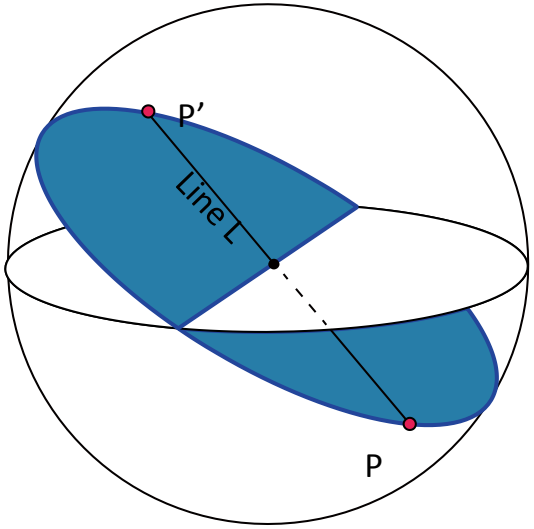
$\tan\beta=\tan\alpha * \cos\gamma$

γ: angle between true dip direction and apparent dip direction

Spherical projection

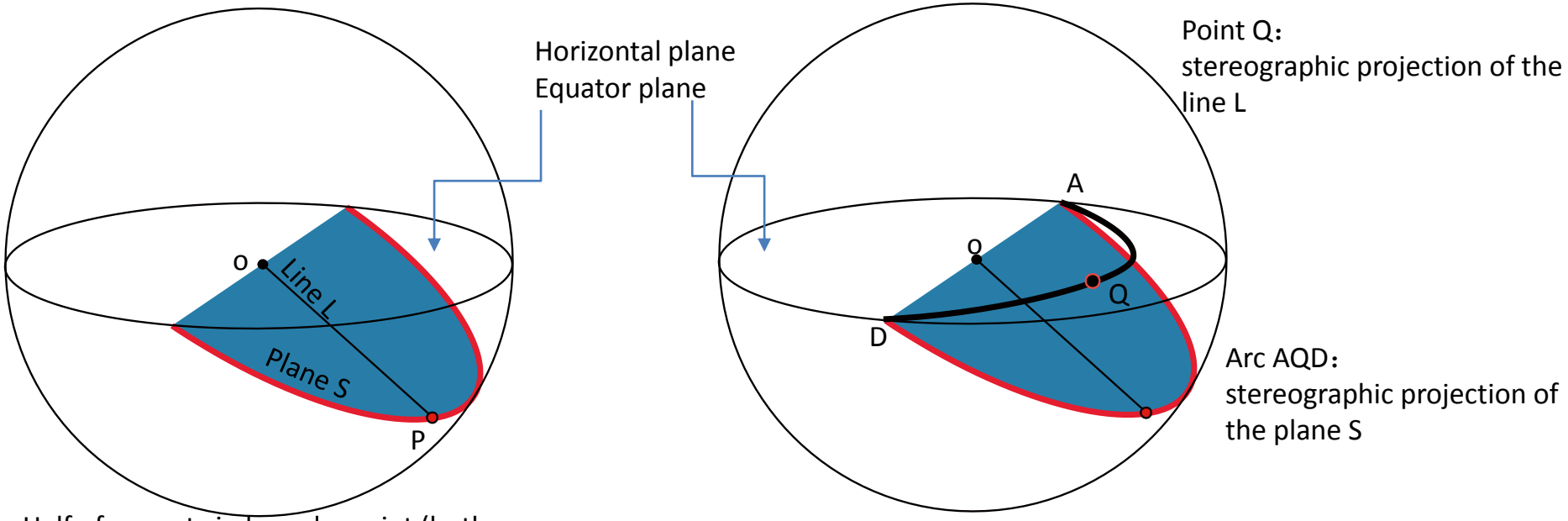
- Describe orientation rather than Position
- A plane passing the center of a sphere (globe) intersects the sphere with a great circle (a circle with the same radius as the sphere; the red circle in the first diagram below) which is the spherical projection of the plane.
- A line L passing through the center of the sphere intersects the sphere at two points (P and P'), one in upper hemisphere and the other in lower hemisphere. These two points are the spherical projection of the line.





Stereographic projection

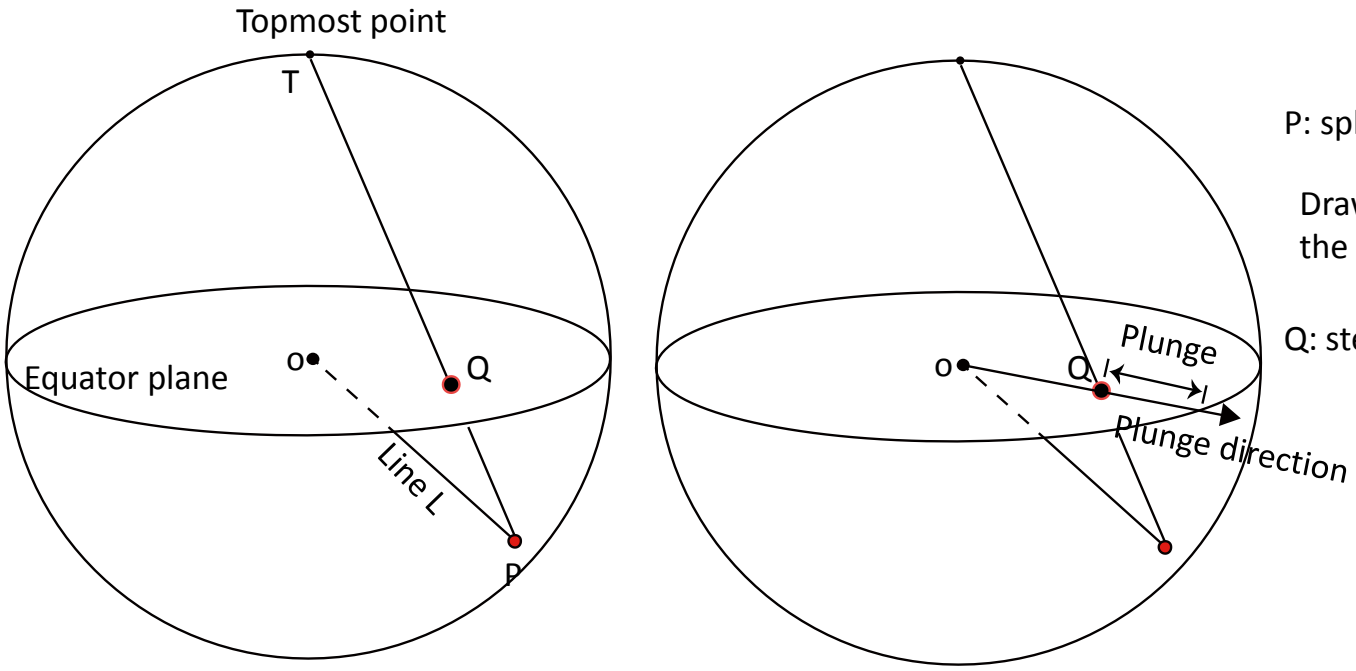
The spherical projections (great circles or points) on the lower spherical surface are projected onto the equator plane: stereographic projection (Lower hemisphere projection).



Half of a great circle and a point (both in red) on the lower spherical surface

Stereographic projection of a line

How is a line L plotted as a point on the equator plane?



P: spherical projection of line L

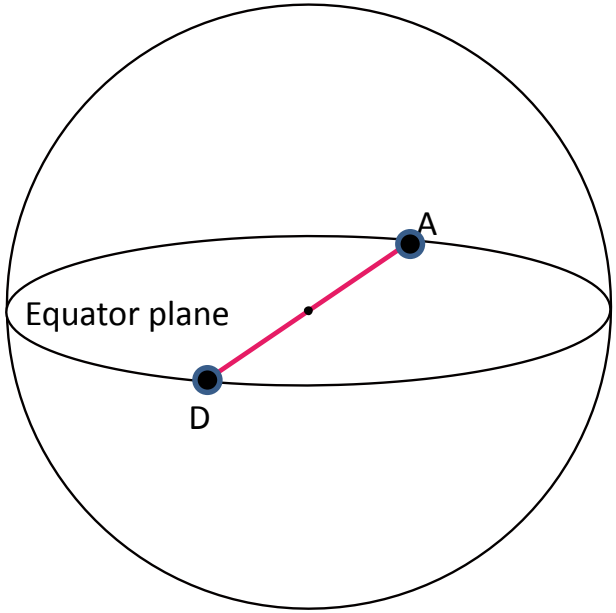
Draw line TP and it intersects the equator plane at point Q

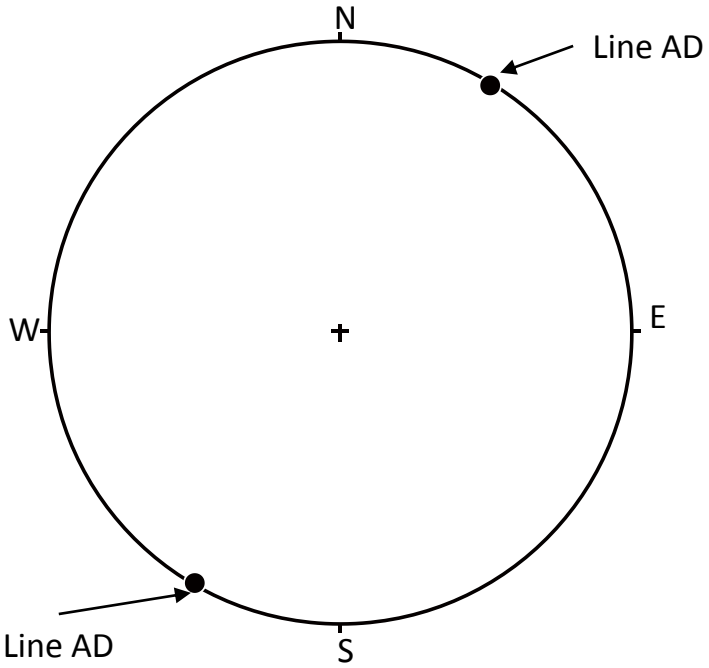
Q: stereographic projection of line L

Stereographic projection of a line

- A horizontal line AD

What is its stereographic projection?

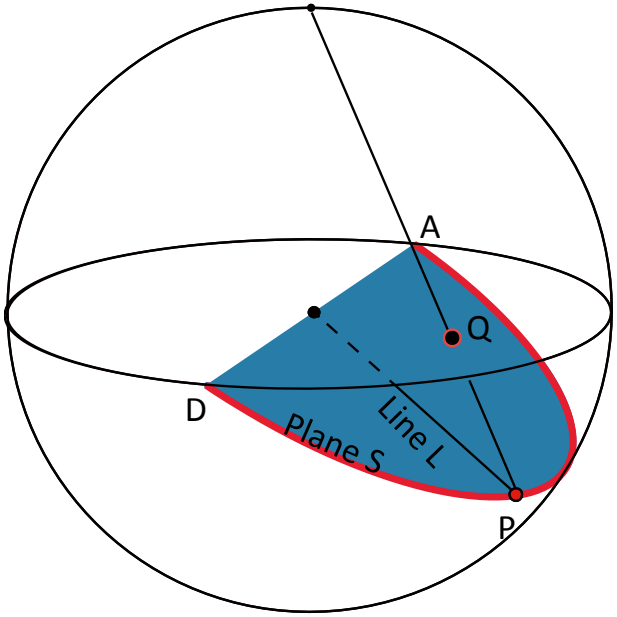




Equator plane; Plan view

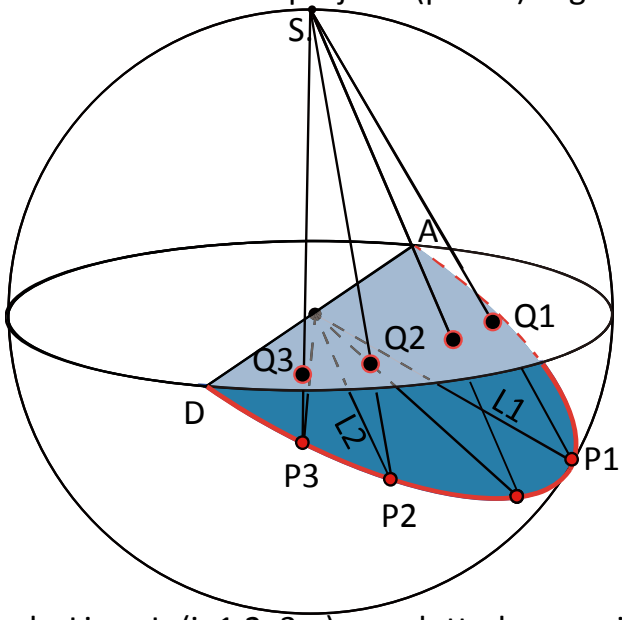
Stereographic projection of a plane

- How is a plane plotted as a great circle on the equator plane?
- A plane is plotted as an arc on the equator plane. We refer to this arc as a great circle.

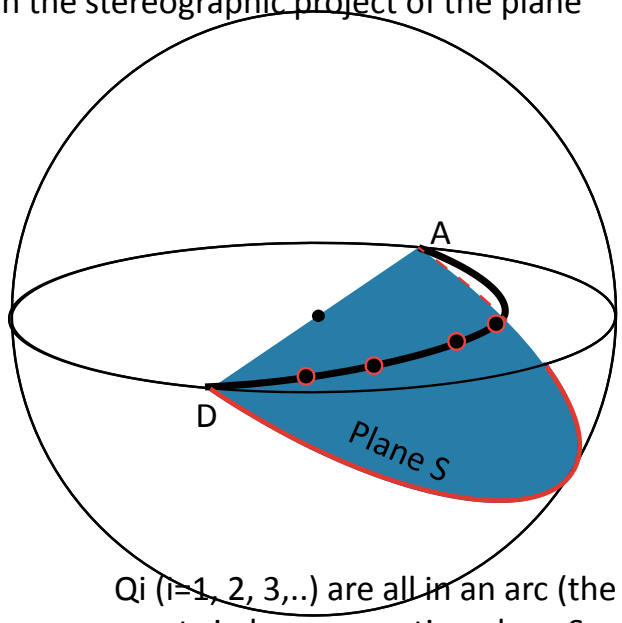


A Line L is plotted as a point Q

Lines L_i (i=1,2, 3,..) are in the plane S, so their stereographic projects (points) align in the stereographic project of the plane

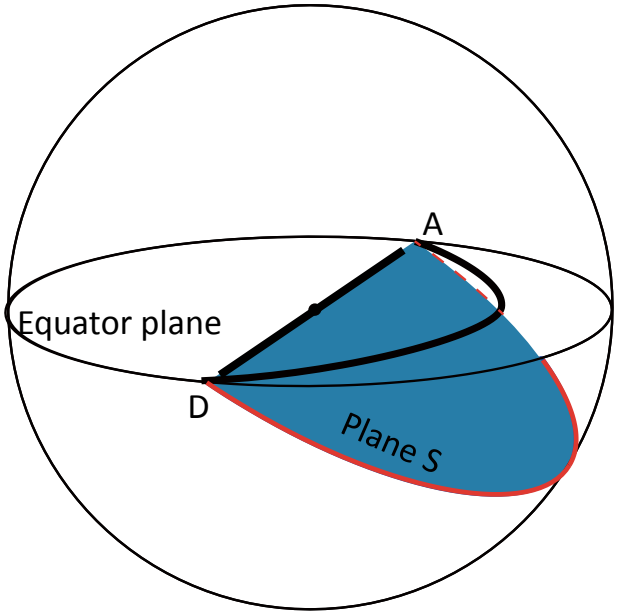


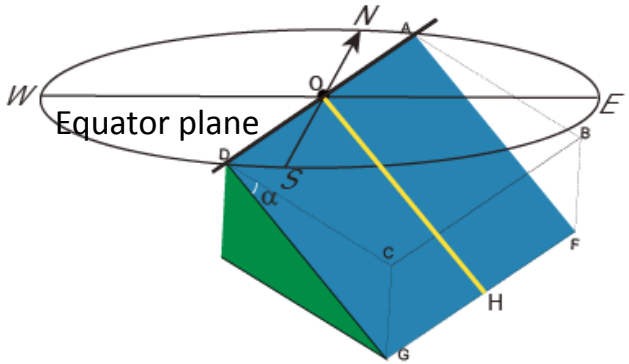
Similarly, Lines L_i (i=1,2, 3,..) are plotted as a point Q_i



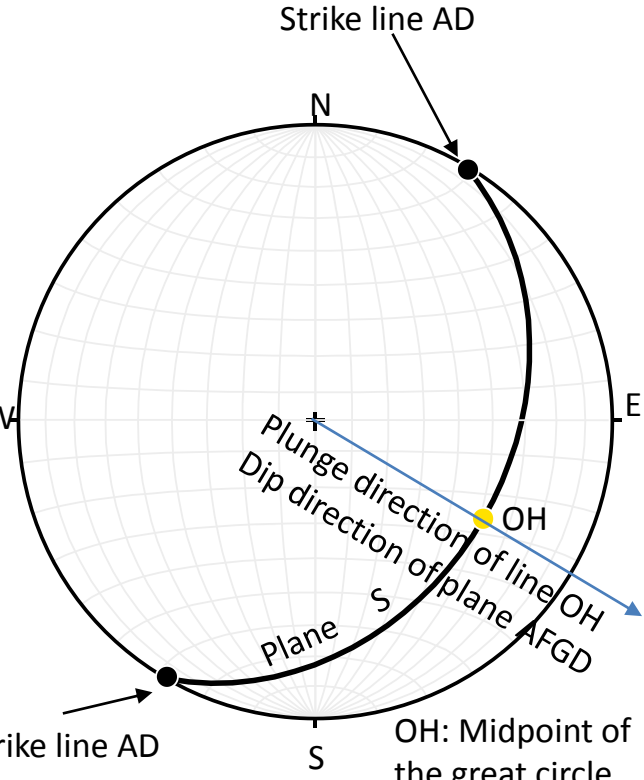
Q_i (i=1, 2, 3,..) are all in an arc (the great circle representing plane S

Stereographic projection of a plane





Line OH is perpendicular to line AD



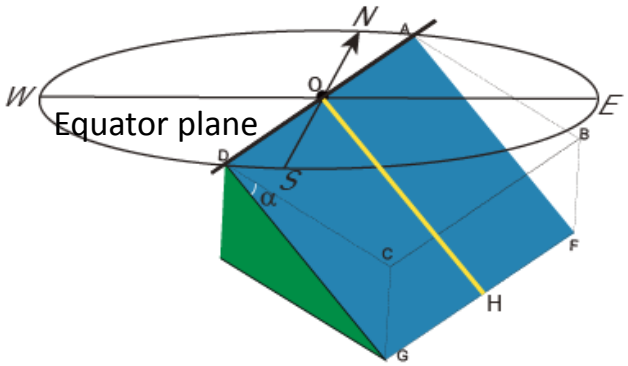
Strike line AD

OH: Midpoint of the great circle

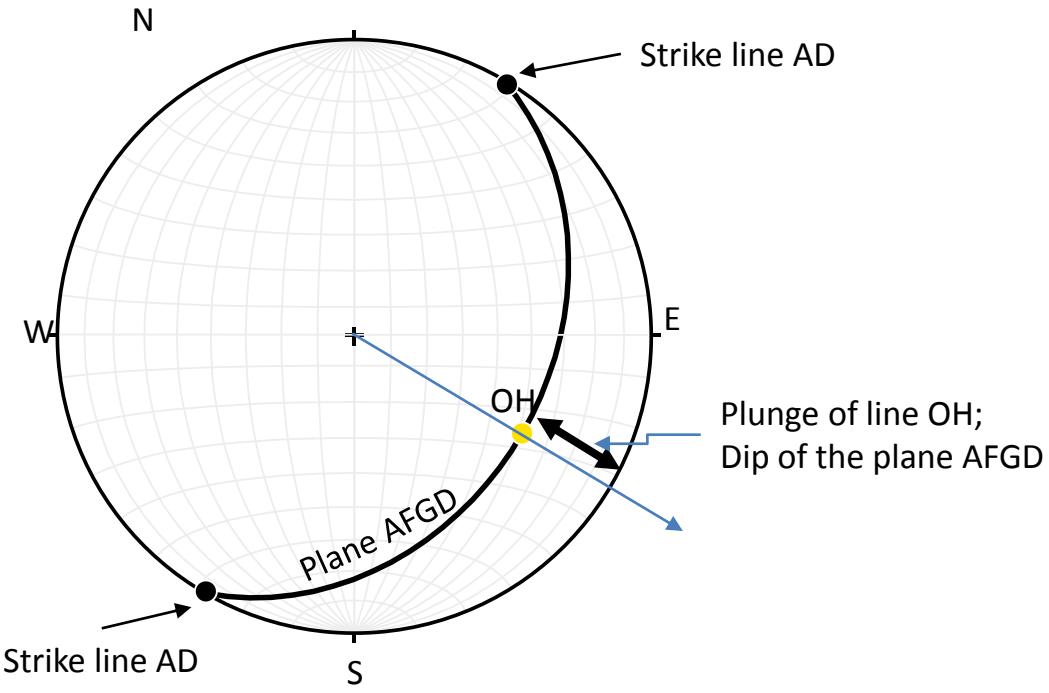
Plan view of the Equator plane; Stereographic projection

Orientation of the great circle on the equator plane: determined by the strike or dip direction

Stereographic projection of a plane



Line OH is perpendicular to line AD



Shape of the great circle: determined by the dip of the plane

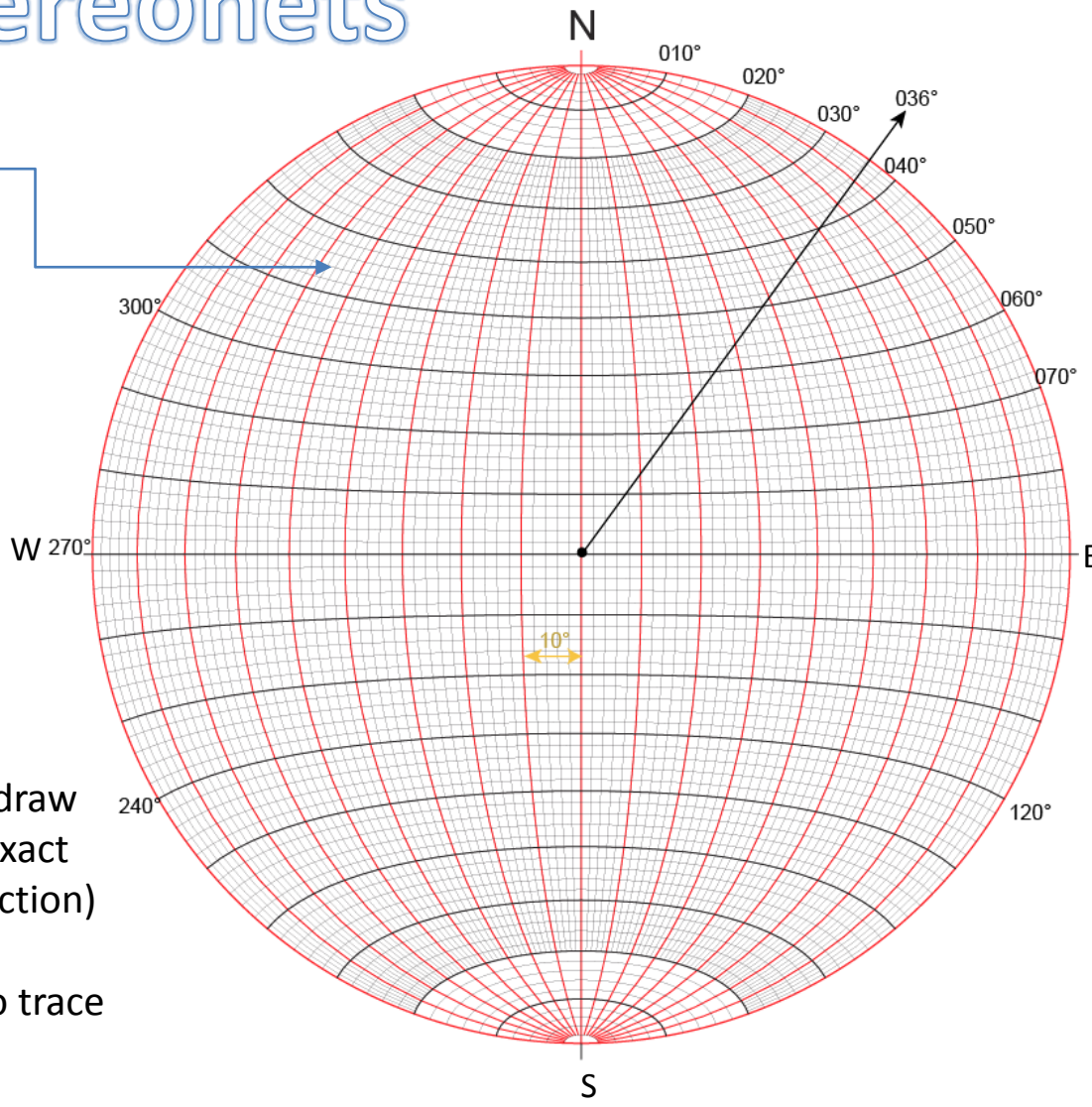
Stereonets

- Great circles

"longitudes"

Small circles

"latitude"



Schmidt Net (equal area)

Use it to trace the great circles on the net to draw great circles on tracing paper. Use it to read exact angles (plunge, plunge direction, dip, dip direction) from the net.
Need to rotate the net or the tracing paper to trace the great circle
Read directions on the primitive circle
Read dip/plunge along N-S (or E-W) line of the net

Plot a plane as a great circle in stereographic projection

S: 030, 20SE (Strike, dip) format

- Draw the primitive circle and mark at least the north point on the tracing paper
- 30 degrees clockwise from true north, on the primitive circle, mark a point (e.g, point A) on the tracing paper.
- Rotate the tracing paper until the mark A aligns with the north point on the net
- Determine whether you should draw the great circle on the left or on the right. In this example, great circles on the left dip towards NW, and those on the right dip towards SE. So in this example, you will draw a great circle on the right.
- Along the E-W line of the net, count from the right end (East end) from primitive circle toward the center for 20 degrees. Trace the great circle there. This great circle represents the plane S

Plot a plane as a great circle in stereographic projection

S: 20, 120 (dip, dip direction) format

You can convert it to strike and dip format and then plot.

Or you can plot directly (steps described below).

- Draw the primitive circle and mark at least the north point on the tracing paper
- 120 degrees clockwise from true north, on the primitive circle, mark a point (e.g., point H) on the tracing paper.
- Rotate the tracing paper until the mark H aligns with the East point on the net
- Along the E-W line of the net, count from the right end (East end) from primitive circle toward the center for 20 degrees. Trace the great circle there. This great circle represents the plane S

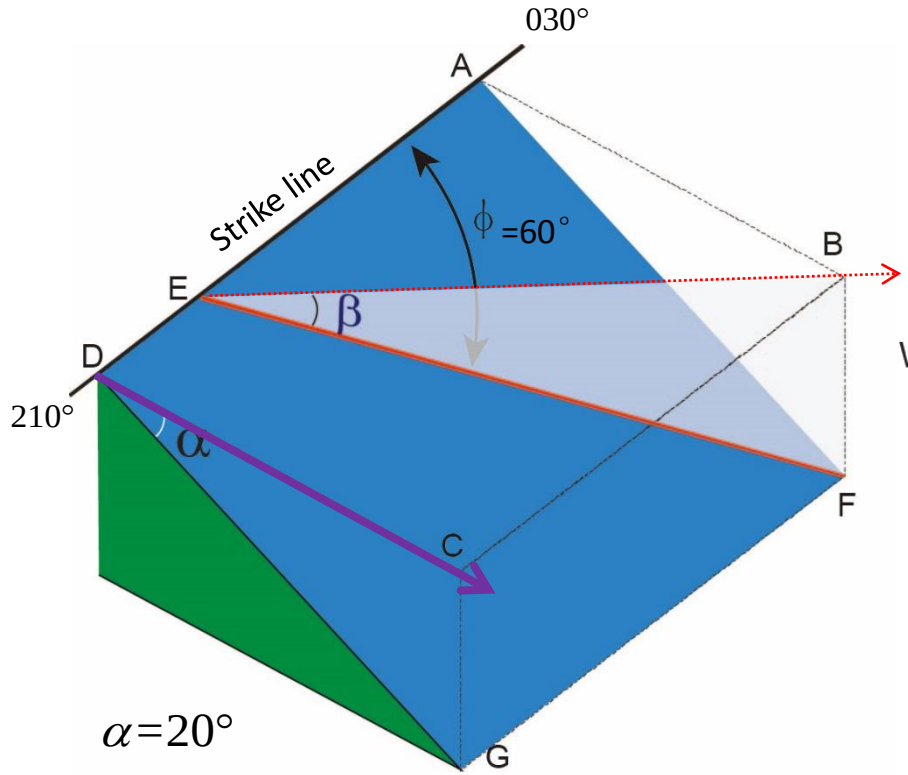
Plot a line in stereographic projection

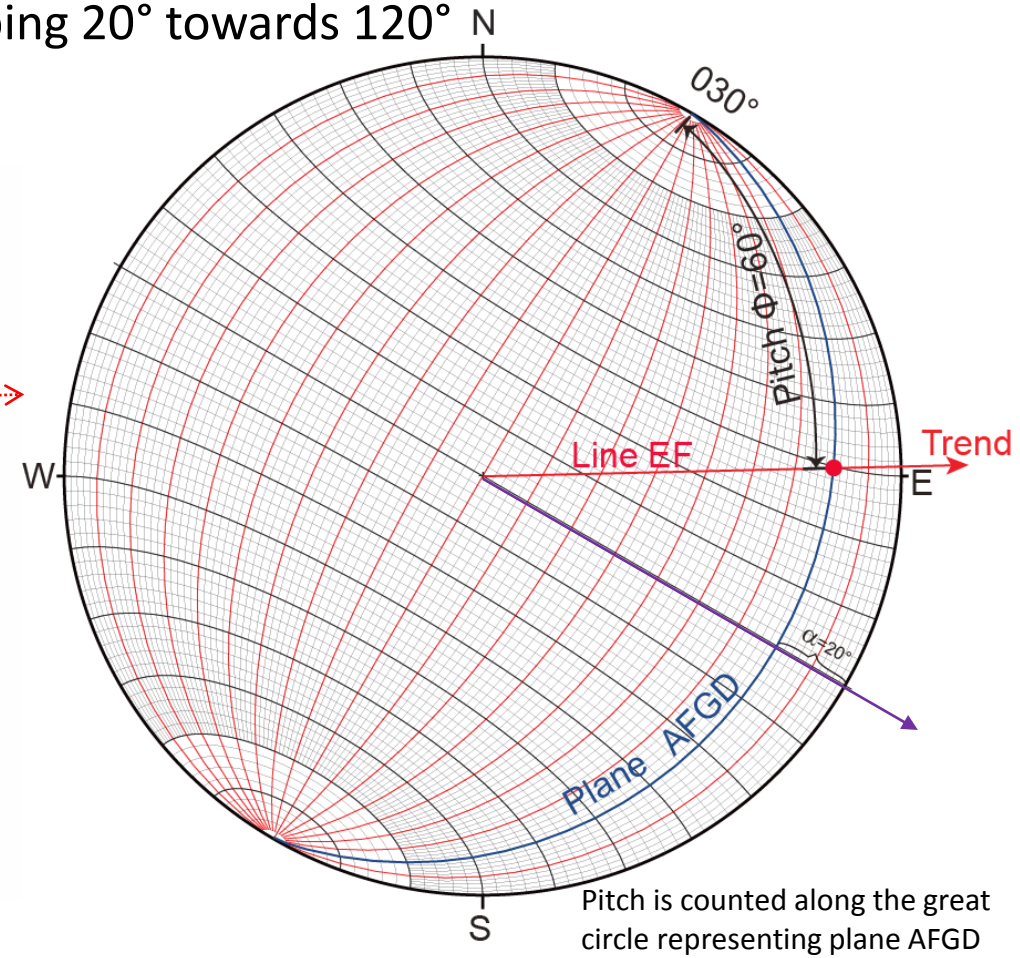
L: 20, 080

- Draw the primitive circle and mark at least the north point on the tracing paper
- 80 degrees clockwise from true north, on the primitive circle, mark a point (e.g., point P) on the tracing paper.
- Rotate the tracing paper until the mark P aligns with the East point on the net
- Along the E-W line of the net, count from the right end (East end) from primitive circle toward the center for 20 degrees, and mark a point there. This point represents the line L

A line plotted using pitch

Line EF pitches 60°NE on a plane dipping 20° towards 120°
What is its attitude?

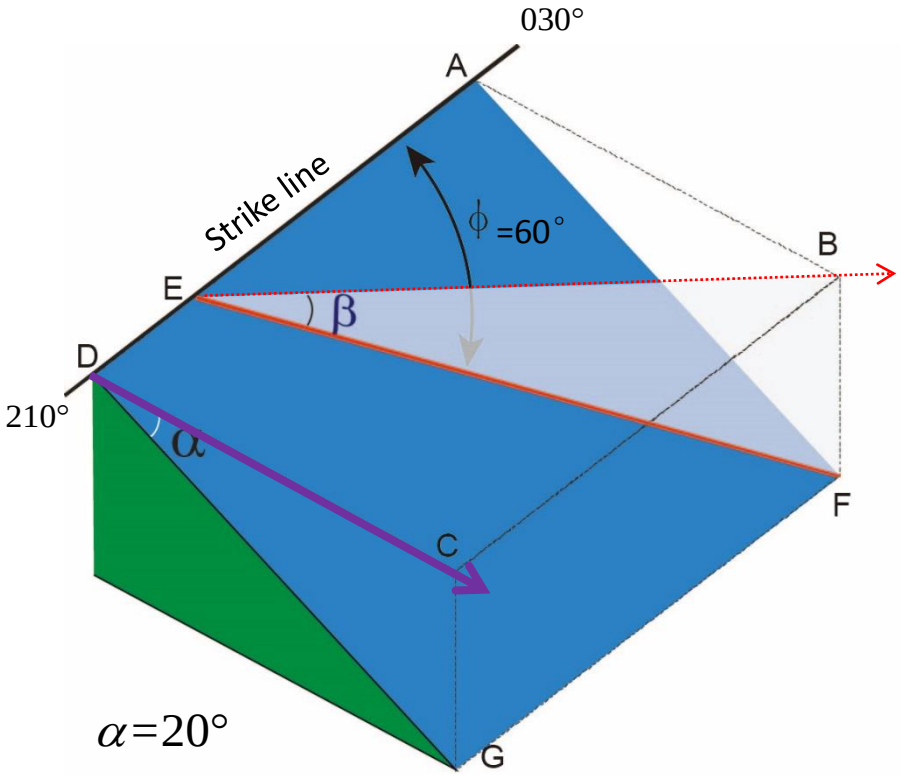


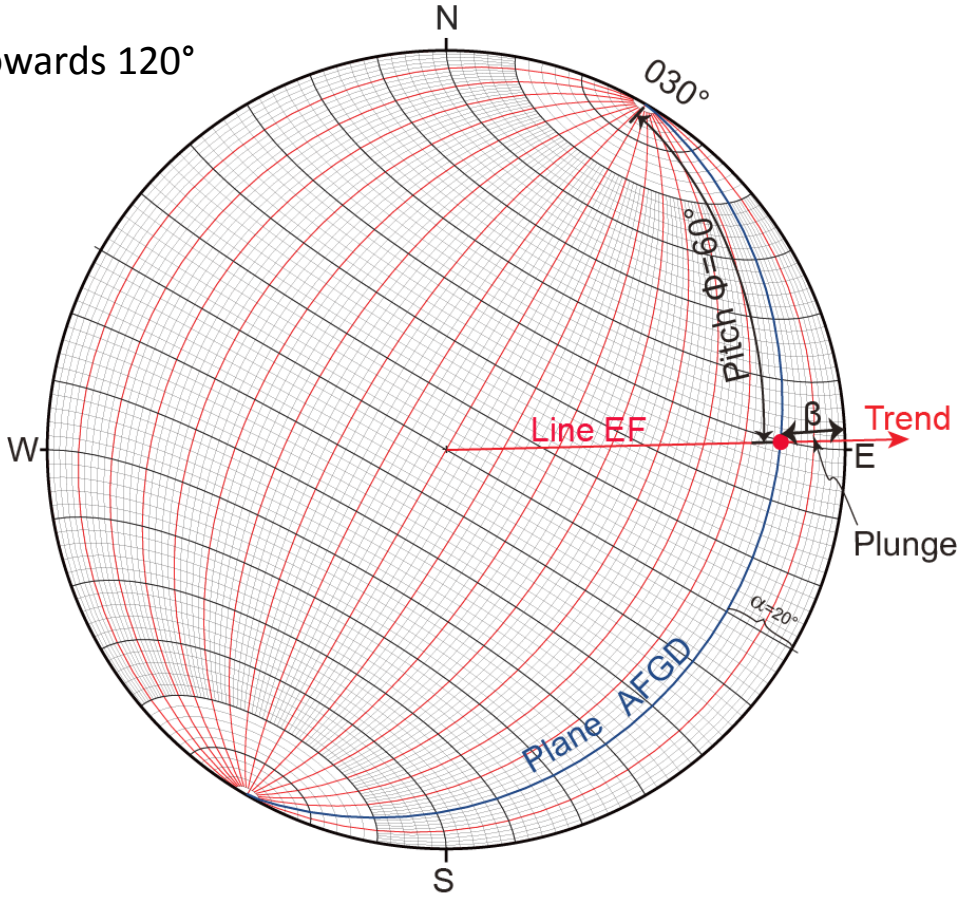


Pitch is counted along the great circle representing plane AFGD

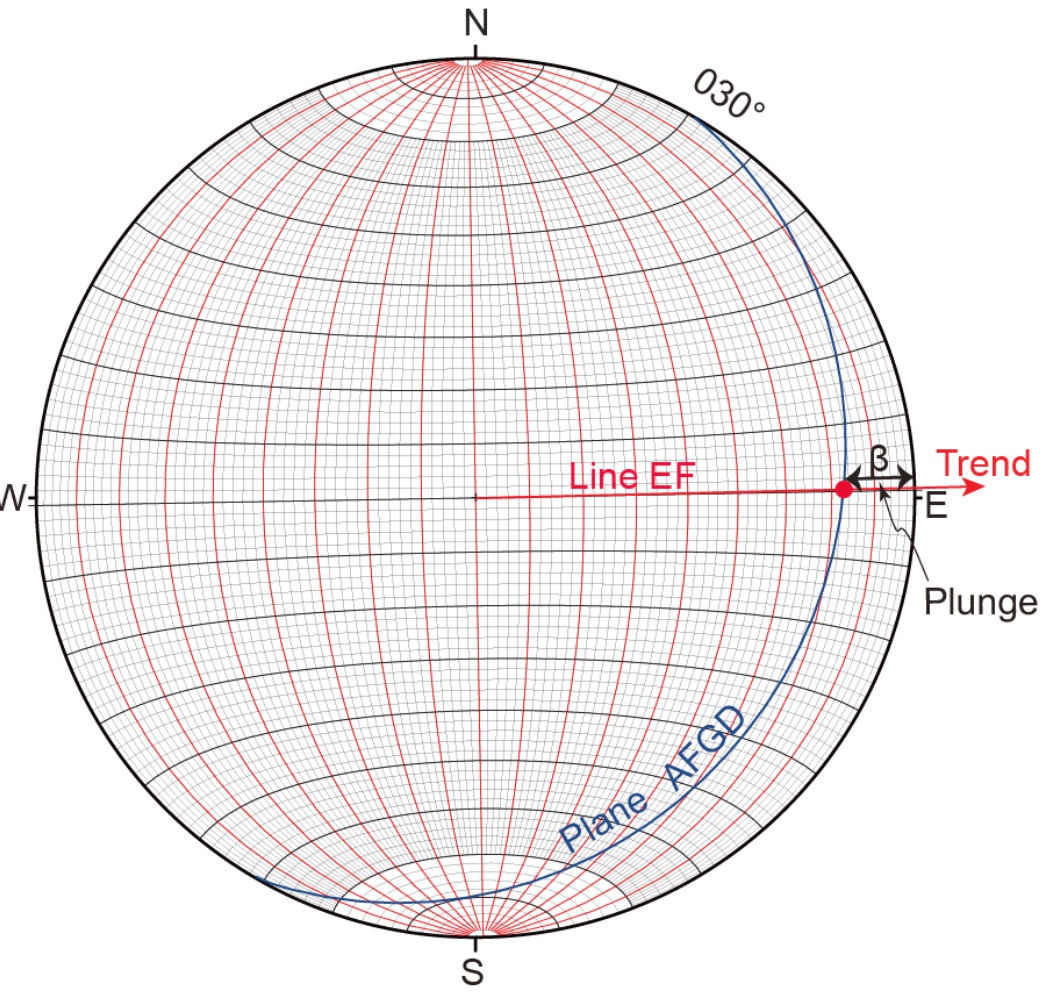
A line plotted using pitch

Line EF pitches 60°NE on a plane dipping 20° towards 120°
What is its attitude?





Need to rotate the tracing paper/net to read β
Note: β should be counted along the E-W or N-S line on the net

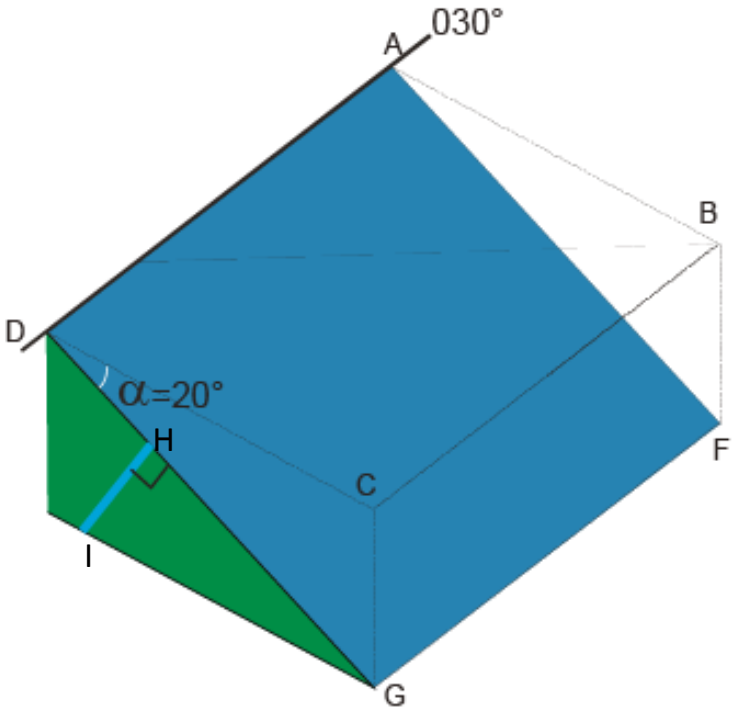


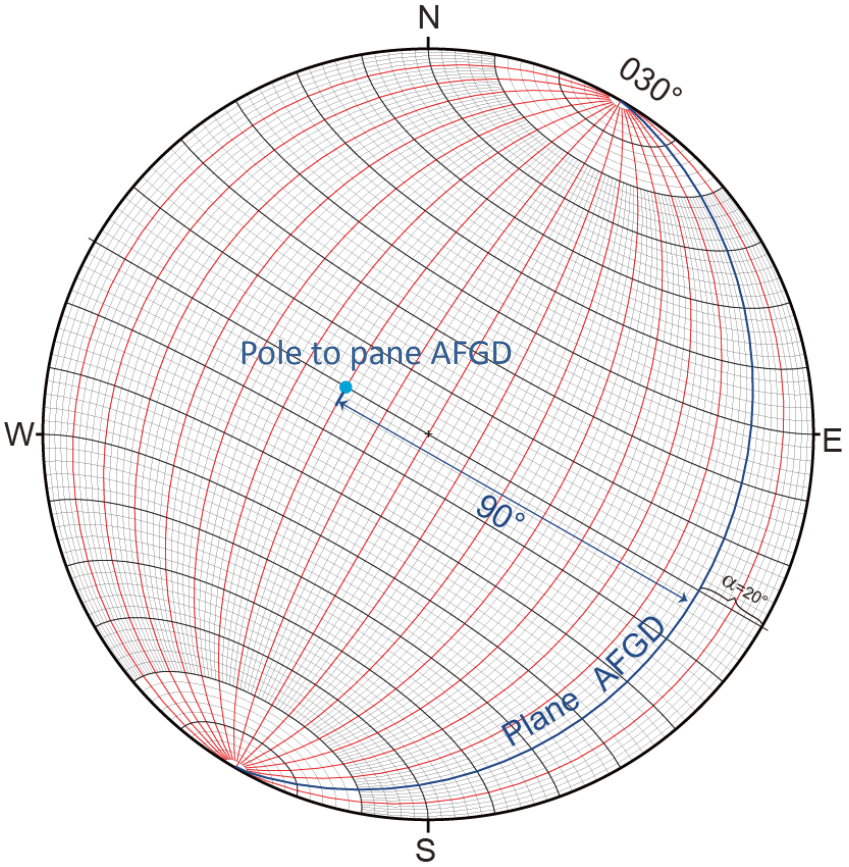
β should be counted along the straight line (great circle: E-W or N-S line of the **NET**; need to align line EF with the E-W line or N-S line before you count the angle) on the net

β=17°

Trend of line EF: 089 °

Plot a line that is normal to a plane: The plane is plotted as a pole





Line HI is normal to the plane AFGD

Practices:

Plot the plane 030°, 55°

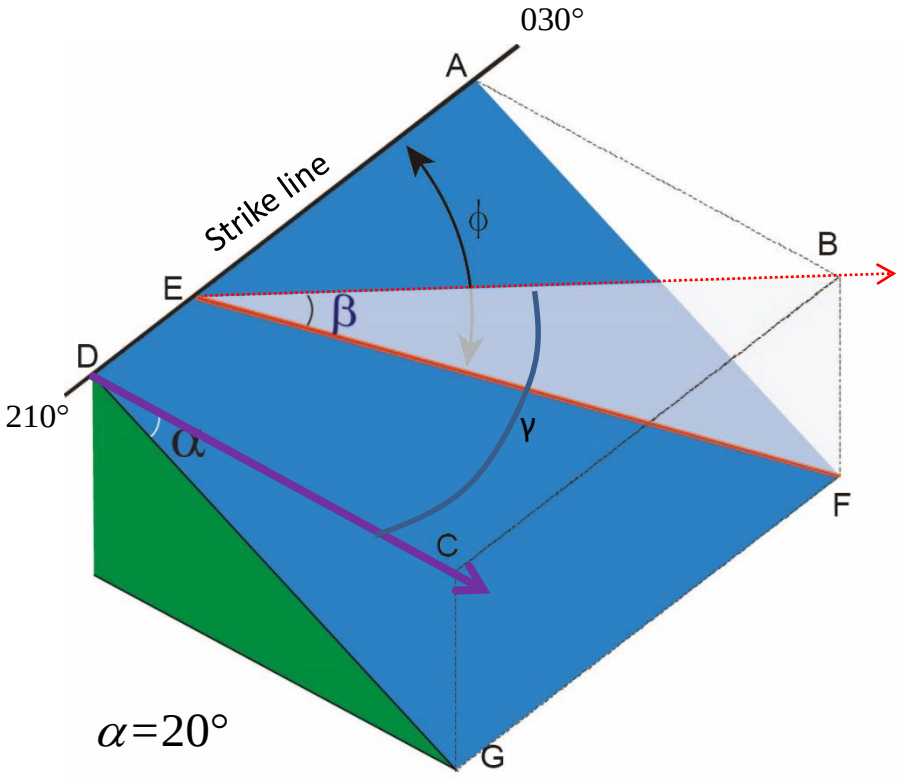
- As a great circle
- As a pole

Plot the following lines:

(1)10°, 100°

(2)Pitches 30° NW on a plane dipping 30° towards 050°

Finding apparent dip



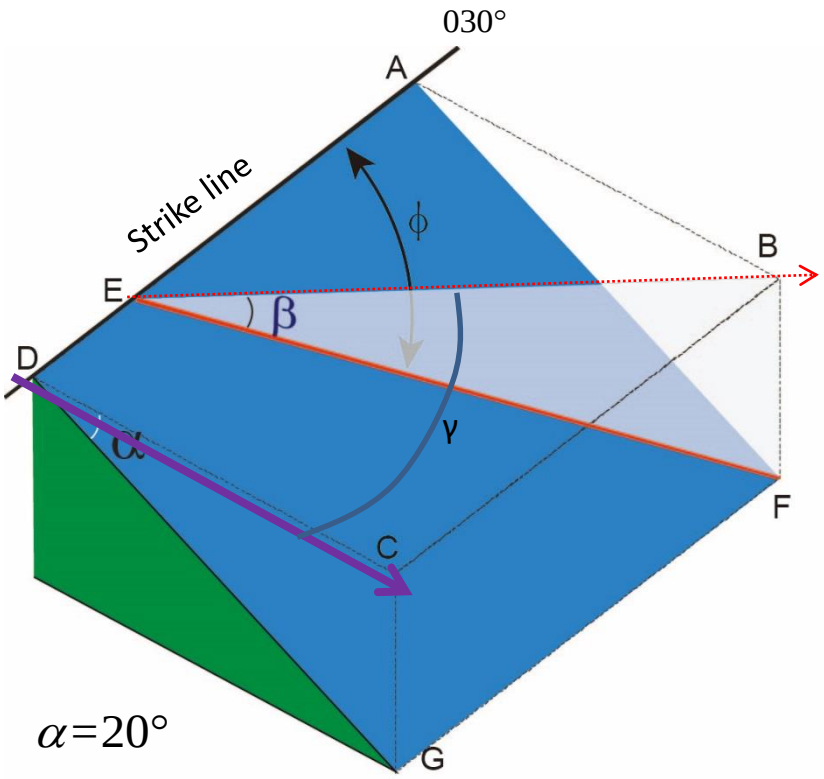
Plane AFGD: 030°, 20°

Vertical plane EBF: 088°, 90 °

The apparent dip of the plane AFGD shown on the vertical plane EBF is β.

Determine β using stereonet.

Finding apparent dip



1) Plot plane AFGD as a great circle
2) Plot plane EBF as a great circle
3) Two intersect at a point representing the line EF
4) β is the pitch of the line EF on the plane EBF, and it is also the plunge of the line EF.
5) count β on the net

Find the plane containing two lines

Lines L1 and L2 are in plane A.

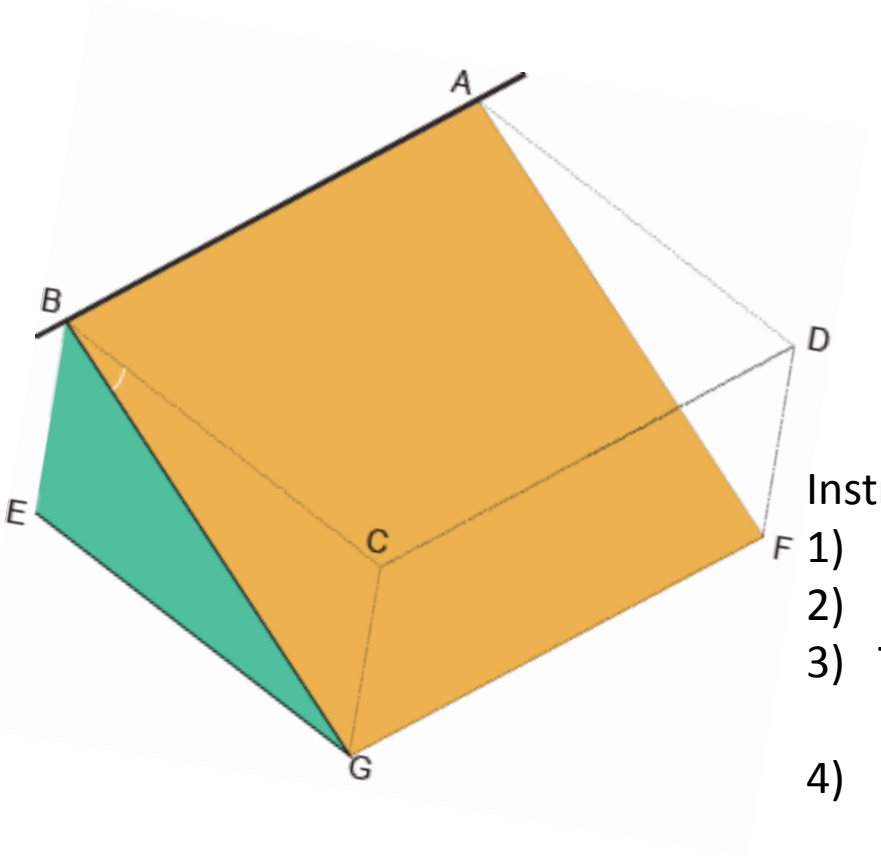
L1: 30, 060; L2: 20, 180

Determine the attitude of plane A.

Instruction:

1) Plot L1 as a point P1 on the tracing paper
2) Plot L2 as a point P2 on the tracing paper
3) Rotate the tracing paper until P1 and P2 align in one great circle in the net
4) Draw that great circle on the tracing paper. It represents the plane A
5) Read dip and dip direction of the great circle from the net

Find the angle between two planes



- Plane ABCD: 010, 30
- Plane AFGB: 040, 50

What is the angle between these two planes?

The two planes intersect at line AB.
Draw a plane BCGE perpendicular to line AB.
The angle between planes ABCD and AFGB is the angle CBG

Instruction:

1) Plot the plane ABCD as a great circle S1
2) Plot the plane AFGB as a great circle S2
3) The two great circles intersect at point P which representing line AB in the block diagram
4) Draw a great circle S3 (representing BCGE) such that point P is its pole
5) S3 intersects S1 at point P1 and intersects S2 at P2. P1 represents line BC in the block diagram, and P2 represents line BG
6) Read the distance between P1 and P2 along S3. It is the angle between the Planes ABCD and AFGB